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Research Centers in transition: meeting new paradigms*

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Abstract

The stagnation in the growth of traditional mission-oriented government research centers in Europe, together with privatization trends and the decreasing weight of government sector expenditures in R&D statistics, might lead to the view that public sector research is shrinking in many European countries. In this paper, we claim that, on the contrary, public sector-driven research in Europe is expanding in size and relevance. To understand this apparent paradox, we argue that it is essential to analyze the dynamics of creation and adaptation of research centers. We illustrate our case with empirical information about three types of research centers: technology centers, joint university centers, and newly-created centers. Both by adaptation strategies to evolving policy models, or by original design, these three organizational types have progressively occupied a middle place in the organizational field of research, with blurred boundaries in terms of public-private ownership, funding sources, and relative output orientation to local markets or to excellence in global science competition. Despite the increasing commonalities in functions, we do not find evidence to support claims of organizational convergence.

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1. Introduction

Long existing statistical evidence shows that the "public" sector of research is reducing its size in OECD countries (OECD, 1989); the government sector share of the total GERD has moved from an average 18% in 1980, to 11% in 2006 (OECD, 2008).

In this paper we claim that there is evidence of a growing role of government intervention in research and innovation, reflected in the evolution of research institutes, despite the fact that the role of "government" as an R&D performer could have effectively diminished.

There are diverse factors that should be taken into account. First, governments themselves - more and more of a supranational and sub-national character- have become new and very active players in some countries (Sanz-Menéndez and Cruz-Castro 2005). Second, governments in many countries are changing the forms of intervention from the traditional "block grant" funding system to a model based on competitive project funding or more strategic (performance based) funding (OECD, 2003). Third, in most European countries, universities (most of them public) have become the main "foci" of government action as regards support to research. Fourth, governments in many countries incentivate business R&D investments and address market failures in knowledge production supporting private institutions which provide knowledge, technology or services to firms. Increasing global competition has led governments to influence and mobilize these non public industrial research centers in support of their policies. Finally, there is substantive change in what governments demand from research institutions with more and more emphasis on the transfer, use and valorization of the knowledge they produce; a movement that others have labeled as the move from mode I to mode II (Gibbons et al. 1994). All these policy trends are reshaping the environment of research centers.

Additionally, statistics do not account properly for the growth of government-promoted or government supported independent research institutes, many of them connected with universities or oriented to the market of research and knowledge services, such the Research and Technology Organizations (RTO).

There is large empirical evidence of this growth from the United States (Crow, Bozeman and affiliates in the National Comparative R&D Laboratory Study Project, NCRDP) and from Europe (EUROLABS project, 2002). The EUROLABS project (almost 800 research centers -public, semi-public or recently privatized-) provided evidence of significant dynamics in terms of creation of new entities: 45% had been created in the previous 20 years and not for profit foundations appear to be the dominant form of ownership for the centers included in the project in Germany, France, the Netherlands, Spain, Portugal, Sweden and Belgium.

It is our contention that the aggregation of entities in three classificatory sectors (government, higher education and firms, and one residual sector for not for profit entities) precludes the appropriate measurement, description and understanding of three relevant processes of change among research actors and in the innovation systems: first, blurring boundaries between different entities in the field; second, the processes of functional convergence around common activities among different types of organizations; and third, the emergence of a new type of hybrid forms of research centers.

Our purpose in this paper is to present evidence on the adaptation patterns and the evolution of research centers in the context of a general dynamic of blurring boundaries between public and private R&D sectors, the changing missions and activities of research institutes and the development of cooperation strategies among them. Our approach incorporates an institutional and organizational perspective, and tries to update some of the contributions made in the last years from different perspectives. We address the following questions: to what extent different types of research institutes are moving to a “semipublic”

space, where there is room for both markets and political interactions? What are the driving forces behind these changes and why different types of research institutes move to a "common space"? And, to what extent, if a trend towards common functions really exists, can we detect processes of convergence in organizational and management models?

Next section presents our analytical approach and some literature relevant to our case. In section three we describe the research design and we present the Spanish evidence. Next we discuss our findings and finally we conclude summarizing the implications for the future study of research centers and for policy.

2. Analytical framework and literature review

To guide our empirical analysis we borrow from different sets of literature: First, the R&D policy models or paradigms of government intervention; second, taxonomies of research institutes; and third, changes in public research institutes, some of them "policy induced" (such as privatization) and some other brought about by "adaptation" of research centers to changing environmental conditions, including the search for external funds, increasing technology transfer and commercialization.

The first set of literature argues that research centers should be analyzed within their environments, being one of the most important environmental elements the dominance of a concrete S&T policy model, or the coexistence of more than one through the emergence of new forms of legitimation (Cruz-Castro and Sanz-Menéndez, 2007).

Bozeman and Dietz (2003), drawing on previous research by Crow and Bozeman (1998), argued that US research policy has been dominated by three policy paradigms: "market failure", "mission" and "cooperative". More recently Boardman and Ponomariov (2008), drawing upon defense laboratories evidence, have suggested an elaboration of the three

competing policy paradigms, bringing our attention to the fact that "cooperation" is becoming a substantive principle of all policy strategies both mission and non-mission.

Our contribution in this paper to these debates is the identification of a new and emerging paradigm or rationale (evident in many European countries, but also in other parts of the world) with the key driver being "Excellence". In the context of global competition for reputation, knowledge and people, governments have launched important initiatives to improve the performance of existing traditional R&D actors (universities or research centers)[4] or creating new ones.

Crow, Emmert and Jacobson (1990), Bozeman and Crow (1990) and Crow and Bozeman (1998) developed an empirical "taxonomy", with the objective of classifying the research laboratories under two dimensions: the degree of publicness and the economic character of the outputs, particularly the market or public characteristics. This taxonomy calls attention to the fact that "boundaries" between public and private organizations are more permeable than before. The term "publicness" was introduced to signal that political authority and control on political resources are exerted on all types of organizations with highly varying degrees as regards the role of government in setting or shaping the laboratory's research agenda, the amount and share of government resources that come from government (via contracts, grants, subsidies, or other vehicles) and government control of the structure and design of the Labs; of course, publicness does not equate "government ownership".

The taxonomy and each of the quadrants (figure 1), allow us to think in the position of the research centre in a singular way and to describe the movements (under market and political forces) of the position of research institutes.

Our argument is that there is a general trend for public and semi public research centers to move to the centre quadrant in the taxonomy, as a way to respond to the demands for the

[4] For example the "Initiative for Excellence" from the German Government.

transfer of knowledge and to gain strategic competencies and be more autonomous, with diversified sources of funding, to deal with both the market and the political environments.

Figure 1.- Classification scheme for R&D organizations

		Level of governmental influence		
		Low	Moderate	High
Level of market influence (nature of R&D	Generic product (low)	Private niche science	Mixed-source science	Public science
	Balanced product (moderate)	Private science and technology	Mixed-source science and technology	Public science and technology
	Proprietary product (high)	Private technology	Mixed-source technology	Public technology

Source: Elaboration based on Crow, Emmert and Jacobson (1990).

We argue that the non governmental industrial research institutes (lower left corner in figure 1) will have the tendency to move into the public sphere, searching for more public funding and aiming to build generic capabilities to deliver more "public technology". In the opposite side, we expect to see movements of the traditional academic institutions, the traditional public research centers, to move –even in the absence of strong external policy shocks- into the direction of "getting more private support" through the development of "problem solving" research strategies, in many occasions linked to excellence paradigms.

Finally, change in public research institutes has been addressed in diverse ways after the seminal contributions of Crow & Bozeman, and still miss country comparative studies, because the usual products are collections of national studies (van der Meulen and Rip, 1994, Senker, 2000 or Cox et al. 2001).

There have been studies determining the impact and relevance of science and technology policies on the configurations of public laboratories (Callon et al. 1992), the impact of policies on the orientation towards collaboration of public research centers with industry (Joly and Mangematin, 1996) or the changes in public sector research and their position in innovation systems (Larédo and Mustar, 2004). This work showed that the formal mission

statement of the institutional affiliation did not determine the activity profiles of laboratories and the deep transformation of missions and functions of the traditional centers have made the distinctions between fundamental, applied or mission oriented research obsolete; the institutions of research are not any longer defined by a given type of research activity, but institutions focus on a given domain and cover the whole spectrum of research activities (Laredo, 2001).

More recently, privatization processes or private managerial changes and their impact on public laboratories traditionally in the hands of government, have attracted the attention of scholars (Cohen, Duberley and McAuley, 1999; Boden et al. 2001, 2004, 2006). In addition to policy-induced changes there have also been "adaptation" dynamics of research centers to changing conditions, and reactions to environmental changes, including the search for external funds, increasing technology transfer and commercialization (Schimank and Stucke 1994; Sanz-Menéndez and Cruz-Castro 2003).

Other relevant literature refers to the management of collaborations, for example in new university research centers (Bozeman and Boardman, 2003, Corley, Boardman and Bozeman, 2006; Cummings and Kiesler, 2007) or the consequences of changes for the management or collaboration (Rogers and Bozeman 1997). For instance Liyanage and Mitchell (1993) have worked on the management and decision making process. They identify three different management styles emerging in the Australian Cooperative Research centers (CRC): "corporate", "research" and "integrated", while there are also three different "decision-making models: an "executive control model" with a strong line of decision filtration, command and control; an "consensus model" where decision are made in consultation with several organizational layers of managers and key partners; and "authoritative model", dominant an academic research, based on direct control of the executive director over

decision-making with is only counterbalanced by advisory committees. We make use of some of these categories to analyze our cases.

3. Similar dynamics in diverse types of research centers

Research centers or institutes are entities conducting research and development as the central part of their missions. We acknowledge that direct ownership or control by governments is not any longer a core feature of many research institutes, especially those that have been promoted or created recently.

In the EUROLABS project (2002) Spain appeared as the most dynamic country in the creation of research centers and that in which most of the new centers, despite their variety of missions (industrial research or academic problem-solving) and promoters (governments or other actors) had taken the form of "semi-public" not-for profit entities. Additionally Spain, despite its low starting level of expenditure in R&D, has had the highest growth rate in R&D expenditure of OECD countries in the last 5 years, as well as the highest growth rate in public budgets for R&D (OECD, 2008) and new political actors in R&D policy: the regional authorities (Sanz-Menéndez and Cruz-Castro, 2005).

For the purpose of building our case we have identified three types of research institutes that provide evidence and insights of the dynamics we would like to illustrate. The first group is the "technology centers", a category of private not for profit institutes doing industrial and technological research. The second group is the "Joint CSIC-Universities centers". The CSIC is the biggest entity performing research and development in Spain. CSIC institutes can be CSIC-only or joint institutes built up in agreement with other institutions, mainly universities. The third group of research institutes is much more diverse and although it may not be as coherent as a group as the previous two, most of the centers included in this group have four common traits: they have been recently created; they have taken the legal form of not for

profit foundation; they have often had some form of government involvement in their inception; and in many occasions they involve existing research organizations or institutions willing to escape from the lack of flexibility in the classical "public" domain for managing research with international standards (see table 1).

INSERT TABLE 1 –about here-

The data and information we have collected is quite diverse, which had led us to take different methodological approaches. First, for the three groups, we have extensively used secondary information and reports of the activities of the Institutes and centers. Secondly, for the group of technology centers we have used a database provided by FEDIT, the Spanish association of Technological Centers, containing diverse indicators of the evolution of its members during the last 5 years. Finally, for the analysis of the CSIC joint research centers, CNIO and some technology centers we have used qualitative information coming from in-depth interviews with researchers and managers. More details are given in each of the subsections.

3.1 Technology Centers

Spanish technology centers are non-for-profit organizations doing applied technological R&D, funded from both public and private sources and have the mission to support Spanish firms, facilitating technology transfer and the adoption of innovative practices and new technologies in traditional sectors, which tend to be populated with SMEs. They are relevant for this paper because, first, they are one of the growing populations in the field of semi-public research centers, second, they illustrate forms of governance structures with both public and private involvement, and third, they have strategically diversified their funding sources, in order to reduce dependency from R&D contracts with industry and build their own R&D capacities.

More than 60 new technology centers were created between 1981 and 2006, only 15 existed before 1980. Although in some cases their creation responded to private initiatives, they were often supported or even directly promoted by regional governments who saw in them a good instrument to foster technology-based innovation in SMEs (Moso and Olazarán 2002). The central government has influenced their evolution through approving a regulatory frame[5] that allow them to participate in competitive R&D funding calls previously confined to universities or public research centers.

During many years the proximity to business clients provided technology centers with some advantage for technology transfer services. However, the situation changed at the end of the 1980s, when universities and public research centers begun to provide research and technology services to the market and to compete with technology centers for clients. At the same time some regional governments started to put more emphasis on the support to universities than before. Technology centers encountered a new situation where they had less stable resources and faced more competition for funds. On the one hand, the level of excellence required when competing for public funds for projects could be too high for them, as they were often evaluated by academic criteria. On the other hand, they would face more uncertainty if they relied only on contracts as a strategy for growth, as service demands by firms tends to be more unpredictable than generic R&D, provide less scope for re-utilization in other projects, and may come with intellectual property restrictions.

Acknowledging that contract R&D would always have to represent an important part of their activities, some of the technology centers took the strategic decision to change priorities and started to invest more in own R&D projects than in other types of activities; to finance their "own" R&D they needed to increase their level of public funding.

[5] The central government created a national registry for technology centres in 1996.

In 2002, the FEDIT approved its Strategic Plan for 2002-2006, and set objectives on the transformation needed. The trade-off faced by technology centers if they wanted to move from a client-based model focused on R&D-on-demand model towards a generic R&D model, providing advanced technological services to firms, was clearly stated: *"Technology centers should avoid to focus too much on clients, as this would lead to a loss of technological capacity, jeopardizing a sustainable future. On the other hand, a strong bid for basic research, although oriented, can break their connection with the productive sector and make them lose efficiency as technological bridges"*[6]. Key to the change of strategy was also the need to reach international markets and build capacities to be able to play on the same field as European counterparts such as TNO, FhG and VTT, which not only are much larger organizations but also count with stronger direct financial support from central governments than Spanish technology centers that do nota have more than 25% of their total income.

Consistent with the strategic decision to move towards more generic R&D, in 2004, FEDIT introduced a number of new conditions to become a member: First, to have a sufficient number of qualified staff; second, to have a sufficiently high and stable total income; third, not too dependent from public sector (non-competitive funding below 30% of total annual budget); and fourth to devote more than 25% of total annual budget for R&D and innovation activities.

The evolution of technology centers along different dimensions between 2002 and 2007 clearly indicates the impact of the decisions made.[7] First, in relation to the direct connection with firms the share of business representatives in technological centers governing bodies has diminished (77% in 2003 to 70% in 2007), whereas the representation of universities and public research centers has increased (3% to 5% for universities; 1% to 2% for public research

[6] Report from the Director General, Iñigo Segura, FEDIT Annual Report 2002.
[7] Based on aggregated information on technology centres associated to FEDIT. We thank FEDIT for having provided us with these data.

centers). Second, the share of employees holding a PhD has passed from 8% to 10%, and that of employees with a university degree from 45% to 51%, which indicates a shift in the composition of staff towards more qualified personnel more adapted for the new mission and functions. Third, public competitive funds have increased as a share of total income from 29% in 2002 to 33% in 2007, whereas public non-competitive funding has been reduced from 14% to 10% during the same period, as it has been the case for public/private R&D contracts, from 57% to 50%. This reflects the increasing importance of generic R&D, which is mainly funded from public competitive funds (FEDIT, 2004). When looking at the evolution of the average income by technology centre broken down by type of activity the shift of priorities from business R&D contracts towards own R&D becomes even clearer. The income dedicated to own R&D projects has increased both as a share of total income and in absolute terms, whereas the share of business R&D contracts has decreased relatively to total income.

Adding to our argument that public investments are not shrinking, it is worth noting that the shifts to generic R&D and more qualified staff have been largely supported with public competitive funds, as own R&D projects are predominantly funded through public competitive calls and the cost of hiring PhDs and engineers has often been shared with the central government through programs to foster the integration of PhDs in the business sector.

Finally, another strategic objective, but more difficult to implement, was to increase the critical mass of research groups with the aim to have more chances to compete with other research and technology organizations in Europe in the international market for competitive funds, mainly European Framework Programme.[8] To date, there has been one successful attempt, although still on progress: Tecnalia, the technological corporation born in 2001 integrating three Basque technology centers that now has seven (Rico, 2007).

[8] Spanish technology centres concentrate around 9% of the total return from the EU Framework Programme for Spain (Callejón et al. 2007).

The rationale for creating Tecnalia was to *become a corporation able to participate in the most advanced international research lines*. It can also be seen as a move to increase the chances to compete successfully with the much larger European research and technology organizations. The technology centers affiliated to Tecnalia seem to have more staff and a higher share of qualified employees than the average technology center, with also almost twice as many employees with PhDs and bachelor and engineering degrees.[9]

In their origins the management model of technology centers was very much determined by their nature as former industrial associations and by their core mission of providing their affiliates firms with services on demand. Accordingly, the management structures of technology centers have always had a significant level of representation from the industrial and business sector, and research priorities, very much oriented to industrial applications, were drawn either from sectors' interests or following enterprises' demands. Therefore, the decisions of the basic orientation of the center were taken by the board, and filtered down to the working units. Longer term research planning or training components were poorly reflected in the organizational structure as compared to the commercial function.

As we have seen, technology centers have confronted challenges and changes in recent years that have affected their management modes. Governing boards have been enlarged to include more regional representatives with broader interests in the socioeconomic relevance of the work of the centers for the region. It is clear from the annual reports and some qualitative information gathered through interviews that more and more, research planning and agendas in technology centers are built up over two different temporal frameworks and two levels of decision making. While most centers have kept the short-term projects addressing firms' needs through contract research, some of them have also enlarged their functions to include the development of medium-term generic projects and training of

[9] Own calculations based on information from Tecnalia members annual reports and FEDIT database.

researchers. Decisions about this second type of research are mostly taken at the top management level, but following consultation processes with several organization layers of managers and working units reflecting a consensus-based approach to decisions about lines of research.

3.2. CSIC-University Joint Research Centers

CSIC is the largest public performing research institution in Spain; it exists since 1939 and is similar to the Max Planck Society in Germany or the CNRS in France. It covers all scientific domains and performs basic and applied research. It has almost 130 institutes, of which 49 are joint centers. Joint centers are research centers in which the ownership is shared between the CSIC and another institution. Half of them are in the biology and biomedicine areas or in physics.

In this section we focus on those that involve agreements between the CSIC and universities[10]: there are 43. CSIC-university joint centers are institutional arrangements that bring together researchers from a CSIC institute and faculty from one or several departments of a single university. Their infrastructures are located in the university campus in the majority of the cases.

Joint centers are relevant for the arguments of this paper for several reasons. Firstly, they constitute one example of the blurring boundaries in the organizational field of public research. In that sense, at their origin they represented an institutional innovation in the university environment, traditionally organized across departments and schools; at the same time, they illustrate the adaptive movement of a classical PRC towards spaces of collaboration with other public actors in response to evolving policy models. Secondly, they provide examples of how institutionalized collaboration facilitates the diffusion of organizational

[10] The regional government of the territory in which the university is located usually participates in the agreement too.

practices. Finally, the growth of joint centers between universities and public research centers is part of a larger European dynamic.

Research groups are mixed in their composition and directorship is also shared. However, university faculty keeps their teaching duties at the schools and departments, whereas in the CSIC, tenured researchers are full-time scientists without such obligation. The CSIC is the only public research centre with similar career structures as that of universities. Joint centers staff remain employees of their own institution, and tenured positions are offered not by the joint centers but by each of the partner institutions, that maintain control over recruitment, promotions or leaves. This is likely to diminish the level of integration and institutional identity, but, at the same time, reduces the potential conflict between the centers and the departments over staff time, and reduces the chances of academics' conflict of roles. Thus, if some kind of isomorphism takes place among the two parts, it is driven by diffusion of practices rather than by strategic managerial decisions.

Their infrastructure is funded by a collaboration agreement between the CSIC and the university, and therefore, they do not have to compete with departments for university internal funds. Since neither universities nor the CSIC fund their institutes or departments with block grant funds for research, the standard mechanism for funding research activities is through researchers applying for grants to competitive sources, or engaging in contracts with industry.

Joint centers originated in the seventies and expanded from the mid eighties onwards. CSIC newly-created centers have predominantly been joint centers; in the period 1980-1999 they represented the 52%, while since 2000 they represented the 78% of the centers created. Two main factors account for this. First, regional governments have promoted the creation of research centers in their territories; the local universities have been the natural institutional context for these developments. Universities have seen in the creation of these structures adjunct to departments a mechanism to foster research in areas in which they had strong

capacities. Secondly, the CSIC has adapted to the increasing role and weight of the university sector compared to the governmental sector in the overall R&D spending and the greater degree of competition for resources involved in this trend.

Although joint centers have represented an institutional innovation, it must be acknowledged that the risk involved in these cooperative ventures has been very modest, and that partners have been rather conservative. One the one hand, they have kept the highest degree of autonomy in employment decisions, one of the key assets of public research institutions, and staff scales have never been integrated. The majority of research staff in these centers has either academic or scientific tenure, positions which in Spain are granted with civil servant status, and therefore life-long employment, even in the remote case that centers or departments are closed. On the other hand, by its very nature, it is not expected that joint centers have a self-financing strategy, so the perceived pressure to compete in the markets for public competitive or private funding, is not higher than in the rest of the university departments or CSIC own institutes. Joint centers have existed for decades now and they have not evolved as something more or different than the sum of two parts. They are better understood as coalitions coming from classical research structures that, in the absence of strong managerial strategic approaches, have run in parallel to dynamics in their mother institutions.

The qualitative empirical evidence that follows comes from a study of 25 university departments, five of them belonging to a joint research centre with the CSIC[11]. We tried to address the questions of whether joint centers had staffing policies different from those in traditional academic departments, and the extent to which joint centers have been able to

[11] We conducted more than one hundred in depth interviews addressing a variety of issues related with the management of research and the dynamics of academic and research careers. In these five departments (3 from physics, one from biology and another from chemistry) we conducted 20 interviews, 4 with department directors, 5 with directors of research groups, 4 with other tenured academic staff, and 7 with non-permanent academic staff.

developed a top-down strategic approach in which the management and planning is above the research and education functions in the organizational structural.

In a national context in which universities are rather resistant to change and reform, we have found evidence that joint centers entail dynamics of diffusion. University departments involved in joint centers have been influenced by CSIC practices and developments. We have identified two dynamics at the micro level.

The first one is related to research careers and criteria for recruitment. University academic appointments in Spain have traditionally followed internal labor markets dynamics by which a PhD degree awarded by the hiring department and prior teaching positions within it, have played a key role in selection processes for tenure. At the beginning of this decade, the central government launched the Ramon y Cajal program. It was designed to provide subsidies to PRCs and universities for contracting full-time researchers for 5 years in priority or strategic fields (Cruz-Castro and Sanz-Menendez, 2005).

One of the key findings arising from the interviews is that these contracts have had a significant impact on changing the traditional implicit rules of university recruitment in the last years. These researchers (approx 3.500) have been granted with a reputation of good quality and excellence, and contracting organizations have committed to provide tenure or fixed employment opportunities at the end of the five-year period. This has introduced an unknown level of competition in the internal queues of the departments and often some degree conflict.

CSIC-universities joint centers (and departments attached to them) have made a significant use of Ramon y Cajal postdoctoral contracts, but most importantly, what is distinctive is that they have clearly adopted this contractual figure as a form of tenure track appointment, so that it has become the principal route of entering departments as new tenured or permanent faculty.

The early career path in these centers is more explicit than it is perceived by interviewees from university departments in general. Emphasis on internationalization of research, mobility and scientific productivity in joint centers is noticeable irrespectively of the scientific or technical field. Postdoctoral researchers in joint centers perceive that common socialization norms open the possibility of opportunities in employment ladders in the two sides, the department and the CSIC. This is not the case in traditional CSIC institutes or university departments, where the labor markets are more segmented.

The second diffusion dynamic relates to the systematic adoption of evaluation as a managerial practice. The CSIC was transformed into a public agency in 2007. This reform implied that it would be financed on the basis of a contractual agreement with the Ministry of Finance. The conversion into an agency involved the request, for all CSIC centers and institutes, to periodically elaborate a four-year strategic plan, subjected to external peer review. Interestingly, although university academic staff in joint centers was not requested to participate in those research evaluation exercises, however, some of these departments decided to evaluate themselves in parallel. It must be said, however, that these decisions were taken at the micro level of the departments and research groups, and did not imply a managerial strategy at the center level and had no distributive consequences.

In sum, university departments in joint centers show clearer career expectations and paths for new recruits, and put greater emphasis on internationalization and mobility for those at the beginning of their careers. After tenure, however, there is not a strong culture of individual evaluation performance. Joint centers do not show a distinctive management style different from their institutions of origin. They keep a bottom up management style with emphasis on individual researchers that enjoy high degrees of autonomy (Sanz-Menéndez and Cruz-Castro, 2003). As a consequence, goal setting is the result of the aggregation of individual and research groups research agendas, rather than based on highly structured

research programs. Commercialization of research varies depending on the area but it is also the outcome of the aggregation of the market orientation of the groups rather than an organizational objective. We have not identified a management and planning function in the organizational tree. In that sense, joint centers have inherited the limitations of their partner organizations, and have not so far turned to be the institutional solution to the endemic collective action problems that have historically affected universities and the CSIC.

3.3. Excellence oriented newly-created research centers: "unlimited by design"

We have been arguing that governments have changed the way they intervene in the production and promotion of research. The new centers are very different from the traditional government laboratories that flourished decades ago and which were the main instrument of the government sector as an R&D performer. These new centers hardly fit in the traditional policy paradigms around market failure, mission or cooperative policy models; it is our contention that they represent one key example of what might be called the "search for excellence" paradigm, articulated around policies that aim at enhancing quality, scale, productivity and internationalization of research and around competitive funding and corporate human resources management instruments.

In Spain, we find a number of key examples in this domain, some of them related to actions of the national Government and some others from initiatives sponsored by regional governments. The first is a set of centers created by the Ministry of Health to carry out research with the highest scientific standards, but aiming to contribute to the solution of problems. Among the second set there is a group of the research centers created under the support of the regional government of Catalonia, a region in the northeast of Spain.

At the end of the nineties, the Ministry of Health issued a strategic Plan that included the creation of three research centers to conduct research in high priority areas (cancer, heart, and degenerative diseases). They were created under the legal form of private not for profit

foundations. They get a significant part of their funding from public sources, but also from business and other private sources. They were designed to break away the administrative and organizational limitations and rigidities of the Spanish PRC management model in terms of contracting, staffing, funding and management capacities. They are characterized by a management style sharply different from that of the PRC that created them.

The National Center for Oncology Research (CNIO) is particularly interesting. It was created in 1998 by the Carlos III Health Institute, a classical PRC. The CNIO is managed by a foundation, created simultaneously with the CNIO, named Carlos III Foundation CNIO. The Foundation is owned by the Government, but it is subject to the private law and it has a governing board. The Center is in charge of developing the scientific activity and it has a Director that works with the advice of a Scientific Advisory Committee. The criteria for the selection of the Director followed, in 1998, was his worldwide scientific reputation in the field. The selected Director[12] is still in office.

The number of employees of the centre has grown from 94 in 2000 to 457 in 2007, the majority of them being researchers. Its essential mission is to conduct research of excellence and to transfer the very latest technology in the field of cancer to the Spanish National Health System and to innovative companies. The CNIO is one of the few European Cancer Centers to allocate resources to both basic and applied research in an integrated fashion, thus supporting the interaction of basic research programs with those of molecular diagnostics and drug discover.

The CNIO continues to be a “public” or more precisely “semi-public” institution, with about 50 percent of its budget coming as “hard money” from the government through direct transfers, while the other 50 percent comes from grants (either public or private).

[12] Mariano Barbacid, the head of CNIO, was appointed after having worked in the United States for 23 years. The selection of the Director of the CNIC (cardiovascular research) has followed similar patterns and Valentin Fuster was appointed in 2004 after returning from the Mont Sinai School of Medicine in New York.

CNIO is relevant for the arguments of this paper because it represents an example of a newly created centre, designed, from its origin, to be a center of excellence, and to have the greatest degree of autonomy and flexibility, to compete in the market of knowledge production and transfer, which is more and more international. The way in which management operates at CNIO reflects the flexibility associated with a private organization, derived from its foundation nature. As a center the CNIO has the advantage of being autonomous in terms of strategic planning and daily operations[13].

CNIO management features include high degrees of flexibility and capacity to contract external services, to recruit researchers nationally and internationally, to pay competitive salaries, and to raise private funds in the forms of donations. Changing recruitment and staffing policies was an essential element of the new centre. The first movement was to attract Spanish researchers working at foreign research institutions[14].

CNIO employees are not civil servants, a status which requires passing exams, being EU national and diploma homologations. Not having civil servant status gives CNIO tremendous flexibility in hiring scientists from all over the world and to avoid the salary rigidities associated to public employment. Staff scientists have been recruited internationally and they have been given the chance to bring part of their team with them. Promotion does not follow the traditional rules of academic labor markets or the public sector research in Spain. There is a target to increase the share of foreigners at CNIO, but currently 25 percent of the CNIO's postdocs and graduate students are foreign, as are five of the 35 group leaders.

CNIO is organized along seven research programs each of which has one director and several research groups headed by a senior scientist. There are almost forty different research groups of a small average size of around ten people. 80% of CNIO’s personnel are under the

[13] "That is something the other research centers cannot do; they have to ask for permission for everything either to the [Spanish] research council or to the university" (Barbacid, 2008).
[14] The key element was a good startup package to attract the best people. "We give them three [support] positions, and everything they need for the first three years, within reason" (Barbacid, 2008)

age of 40. Apart from group leaders, the other categories are staff scientists, postdoctoral fellows, graduate students and technicians.

CNIO model represents a radical departure from the past as regards the operation conditions of a research centre in Spain. While having a significant amount of public support, it also has the flexibility of private research centers as regards general management. The managerial mode, with a scientific leader as Director, building a joint organizational strategy, is a departure from the standard way of operation in the traditional academic world in Spain, which resembles a confederation of very small groups or individual researchers acting independently and without any incentive or authority to cooperate beyond the expectation to get more resources from the environment.

Our second set of examples of newly created "public or semi public" research centers comes from the region of Catalonia, around an initiative called "Research Centers of Catalonia (CEREC)". The forms adopted by the new independent Institutes have evolved over the years: they started as networking of existing institutions to pool resources, but still keeping separate staffing policies; they ended up promoting complete independent research institutes with exclusive competence on the recruitment and staffing policy.

Those created in the early nineties usually took the form of "consortium" of Institutions usually involving the regional Government and some universities; in fact the early model was quite similar to the CSIC Joint research centers[15]. Their activities were mostly the result of aggregating the activities of the partners, and in some cases, they could have a common agenda; the target was mainly to get the recognition and the explicit financial support of the Regional Government.

[15] An archetype could be the IFAE (Institute of High Energy Physics).

In a second move, some years later, the new centers have started to take the form of independent not for profit foundations[16], but affiliated institutions still contributed with their own independent staff; in that way the Institutes usually lacked a joint policy of human resources, but the selection of the Directors started to be related with the highest reputation pattern.

Most of this new generation of Catalan centers have taken an approach based on their "own recruitment" rather than on the "aggregation of the human resources of the different partners in a joint facilities" as it was previously the standard. This group is a much more evolved example of the research centers promoted under the "excellence" paradigm[17]: a key aspect of the management in this type of centre is performance evaluation.

These Centers have escaped from the civil servant model; research staff is employed on a contractual basis; recruitment of the head of the research groups is international, and support depends on performance evaluations made by a Scientific Advisory Boards, usually composed by world leaders of research; some of then additionally have created "Industry Advisory Councils", involving industry leaders in their fields of interest as a way of attracting private users and funding.

This new type of centers, designed to reduce limitations, are a radical departure from the traditional model of Management of the Research Centers and universities, in which evaluation practices are not extended and, most importantly, do not entail strong salary or career consequences for scientists, once they enjoy a permanent employment. Also the selection process of the Directors is mainly based in scientific reputations. Research Agendas in these centers appear not to be any longer a bottom up process of aggregation, but a much

[16] Archetypes of these centers were for example the IDIBAPS (Institute for Biomedical Research "Augusto Pi Suñer") or the IEEC (Catalonian Institute for Space Studies).
[17] Archetypes of the new generation are: CRG (Centre for Genomic Regulation), ICFO (Institute of Photonic Sciences), IBEC (Institute for Bioengineering of Catalonia) or IRB (Institute for Research in Biomedicine).

more “consensual” mode of strategic planning with a strong component of authoritative decision- making.

4. Discussion

The empirical evidence we have presented has shown that different types of research centers have confronted changes in their environments and have developed common processes of adaptation and change, with similar strategies and moved into a “semipublic space”, despite coming from locations more at the extremes in the different taxonomies. They all show a tendency to diversify their funding sources, enlarge their functions (we have found research, transfer and training in all of them), and engage in cooperative ventures. The key drivers behind these movements are the changing policy models at all levels of government, favoring excellence, cooperation, transfer and problem-oriented research, and the corresponding change in the funding instruments, which have increased the level of competition in the research markets, local, national and global. However, the extent to which these processes have implied convergence in organizational forms and managerial models is rather low.

The case of the technology centers shows the evolution of formally “private” industrial research institutes into a much more “public sphere”**.** Technology centers individually through changes in their funding patterns, and by collective action through their association, have made movements: to become more public (getting more stable public funding and involving more policy makers into their governance bodies) to increase their R&D basic capabilities and qualification profiles, and to develop more strategic long-term approaches. Our account of the factors behind these changes point, primarily, to the perceived need to change to become more independent from the regional resources and direct clients and to grow in order to compete for European funds with other European technology centers. The diffusion of models

of similar centers' collective strategies across Europe has also played a role. Technology centers have corporate management features and, increasingly, decision making approaches combining executive features with consultation within the organizational layers.

The creation of Joint CSIC-universities centers illustrates that also traditional public research centers respond to the changing environment and enter in general patterns of cooperation with other traditional actors, such as universities. Joint centers evidence blurring institutional boundaries, and entail the set up of permanent cooperation schemes in scientific areas where resources needed to conduct research are large. We have identified two main drivers: on the one hand the willingness, on the part of both partners, to respond to the regional government demands to construct capacities in particular areas. For the institutions, the creation of a new center, and the start-up block grant involved in the initial investment, was seen as a growing opportunity; on the other hand, joining forces imply foreseen opportunities to gain visibility, size and critical mass to compete in the markets for project funding, both in basic and applied research. We have found some degree of internationalization and dynamism in these centers, especially as regards the management of early research careers. However, we have argued that the simple movement of joining forces –in the absence of the creation of new organizational identities, or the use of new legal forms- has been a rather conservative move which has not solved the limitations of the managerial academic research model of the partner institutions, especially as regards the lack of strategic planning, and the absence of flexible staff policies based on contracts, incentives and performance, and not in the civil servant model of research careers .

The newly created research centers we have studied have been promoted under a new S&T paradigm (excellence). Their creation demonstrate that governments' intervention, far from diminishing, is intensifying, but under "private forms" or using "private means". This set of new research centers promoted either by national or regional governments have

consolidated in the last ten years, in the context of a policy movement to a more "problem-solving research" and excellence, and entail important changes in the map of actors. This group of centers has adopted integrated managerial styles combining consensus and more authoritative decision making elements, and research programming is usually located at the top level of the organization, occupied by a chief scientist. They have been designed, from its inception, to be located in a middle place as regards ownership, governance and orientation.

These new centers may be also understood and explained in the context of adaptation strategies of existing actors, because they often involve traditional research actors such as universities or classical PRCs. Even when considering the emergence of new research centers under the policy impetus of regional governments we should look at this creation as a way of adaptation of the partners (usually universities and traditional research centers) to cope with the rigidities and the lack of ability to change themselves from within and to move across the paradigms.

The comparison between these new centers and joint centers is revealing. They represent two very different choices of the traditional actors to become involved or cooperate. Cooperative efforts between universities and the CSIC, in the form joint research centers is a low risk venture, where the main results have been economies of scale and enlarged critical size, with poor results in terms of strategic planning capacities or flexible staff management. However, when the traditional actors join into the political initiatives of creation of new centers, with an independent legal status, and under the form of not for profit foundation, there is more than just the effects of economies of scale. This type of centers has adopted a management model without the rigidities of public service, and thus they enjoy contracting and recruiting flexibility. The decision to become involved in a legally independent new center, however entail greater risks for the original institutions, which loose control over employment policy and organizational growth; although strongly publicly supported, newly

created centers have to prove to be self-sustainable and competitive. In that sense, as a population of centers, they are likely face similar challenges as technology centers.

5. To conclude: some implications

On the theoretical ground our findings imply that future studies of the research and technology centers should not take organizational convergence for granted, even in the context of common challenges and opportunities. Additionally, further attempts to develop comparative analysis of policy models might benefit from the inclusion of rationales related to the search for excellence in global competition. We have also suggested that the "cooperative" model could also be connected with the "market failure" model. For instance, some of the traditional models of "industrial research associations" and the support that government have provided to them could be considered as part of one way of government intervention to solve "market failures", helping with the provision and transfer of knowledge and technological services to SMEs and to some sectors that have difficulties to access technology. In this case, policy action to cope with "market failure" could also take the "cooperative" form, especially when "semi public" research institutes are involved.

A number of policy implications can be drawn from our cases. First, research centers have moved to a semi-public common space partially in response to incentives built in policies. However, these incentives have not been able to favor cooperation among different types of centers. Further sophistication of policies would be needed to encourage centers to move beyond non-cooperative competition for the same resources. Second, internationalization of research as a policy target might require instruments that release organizations from their institutional constraints and allow them to build strategic management capacities. Finally, our cases indicate that the key catalyser for change is the breakup, by reform or by design, with public employment rules in research careers.

Given the limitations of cases' analysis, many important questions remain to be solved. Some of them relate to the construction of comparable indicators of the performance of the different types of centers. Although we can formulate normative hypothesis about the superiority of some management features and the flexibility associated with them, we do not know if different models and decision making rules lead to higher scientific and technical productivity, visibility or transfer (commercialization or other). This type of questions can only be addressed at the technical area or scientific field level of analysis. In fact, disciplinary differences are another issue to be explored and whether the dynamics we have identified remain across areas.

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Table 1. Key attributes for the comparison of Research Centers

Features	**Technology Centers**	**Joint CSIC-university centers**	**Not for profit research new centers**
Nature	Non for profit organizations	Public centers	Not for profit foundations
Total number	More than 70	More than 40	More than 15
Created since 1980	90%	85%	100%
Promoters/creators	Industrial research associations and regional government	CSIC individual laboratories and university departments	National and regional governments
Independent legal status	Yes	No	Yes
Mission	Support innovation and improve competitiveness of firms, mainly SMEs	Conduct of research non mission oriented	Conduct of research mainly problem-solving
Functions	Technological services Contract research Own research Diffusion Training	Research PhD training Contract research Knowledge transfer	Research PhD training Knowledge transfer Contract research
Nature of R&D	Private technology	Public science	Public science
Management type	Corporate	Research/academic	Integrated
Decision making	Executive	Consensus	Authoritative
Employment conditions	Private law, competitive salaries for regional business market	Public Employee Law, civil servant status, salaries fixed, low for international academic standards	Private law, competitive salaries for international academic standards
Sources for funds	Mixed - mainly private	Mixed - mainly public	Mixed - mainly public
Pressure to get external funds	Very high	Medium	High
Public funds	Competitive and direct subsidies	Competitive and block grant for running costs	Competitive and non-earmarked block grants
Private funds	Company quotas, R&D and service contracts	Private R&D contracts	Private grants and donations

Strategic planning	Yes	No	Yes
Industry involvement	Very high (board, membership, contracts, clients, etc)	Very low (contracts)	Medium (sponsorship, and some with Industria Advisory Boards)
Directorship	Manager, often a senior engineer with business experience	Academic, internal appointment from staff	Science leader, often recruited internationally
Scientific advisory board	Very few	Some of them	All

Source: Own elaboration.